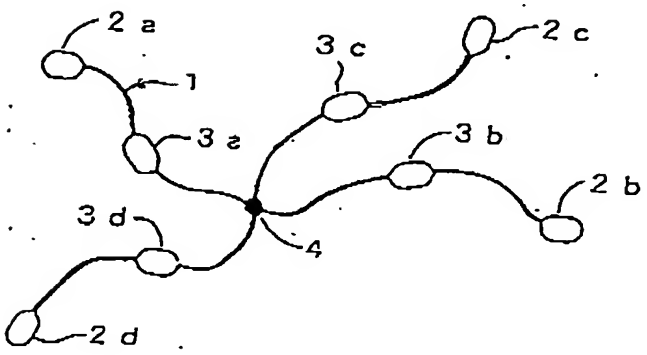


Fig. 1

	CONSTRAINED DEGREE OF FREEDOM / SUPPORTING MEMBER	X-AXIS DIRECTION TRANSLATION	Y-AXIS DIRECTION TRANSLATION	Z-AXIS DIRECTION TRANSLATION	ROTATION AROUND X-AXIS	ROTATION AROUND Y-AXIS	ROTATION AROUND Z-AXIS
COMPLETELY CONSTRAINED	CONNECTOR	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE
COMPLETELY CONSTRAINED	LONG HOLE CLIP	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE
ROTATABLY CONSTRAINED	ROUND HOLE CLIP	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	POSSIBLE
ROTATABLY CONSTRAINED	CORRUGATED LONG HOLE CLIP	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	POSSIBLE	IMPOSSIBLE	IMPOSSIBLE
ROTATABLY CONSTRAINED	CORRUGATED ROUND HOLE CLIP	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	POSSIBLE	IMPOSSIBLE	POSSIBLE
COMPLETELY CONSTRAINED	BRANCH POINT	POSSIBLE	POSSIBLE	POSSIBLE	POSSIBLE	POSSIBLE	POSSIBLE

FIG. 2

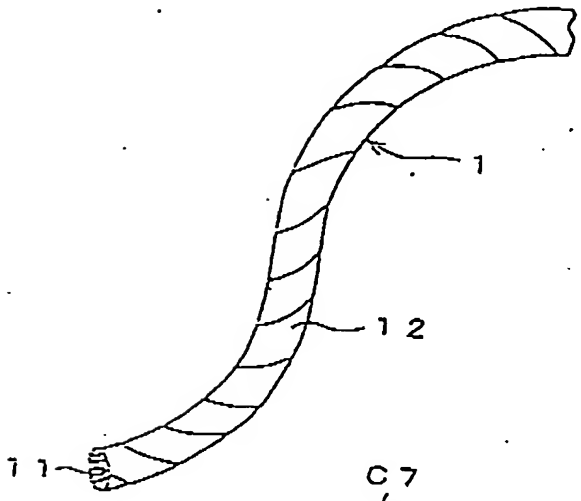


FIG. 3A

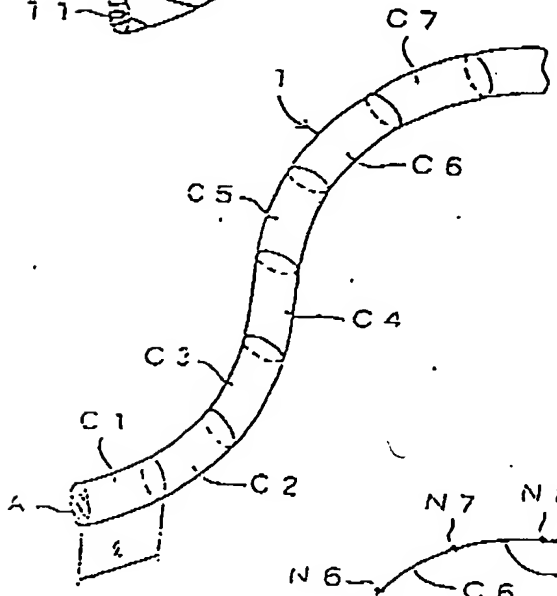


FIG. 3B

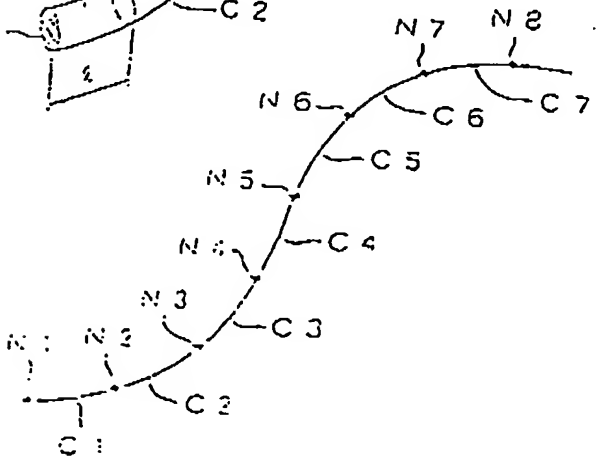


FIG. 3C

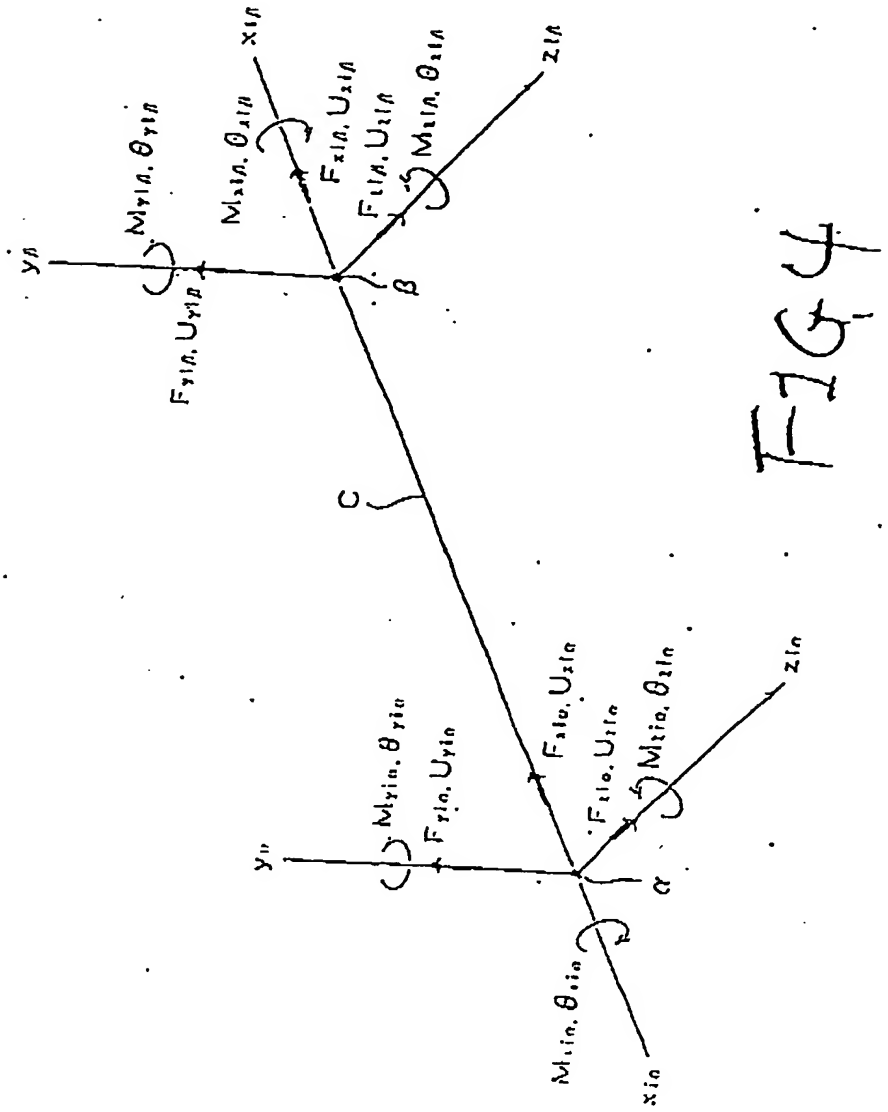


FIG 4

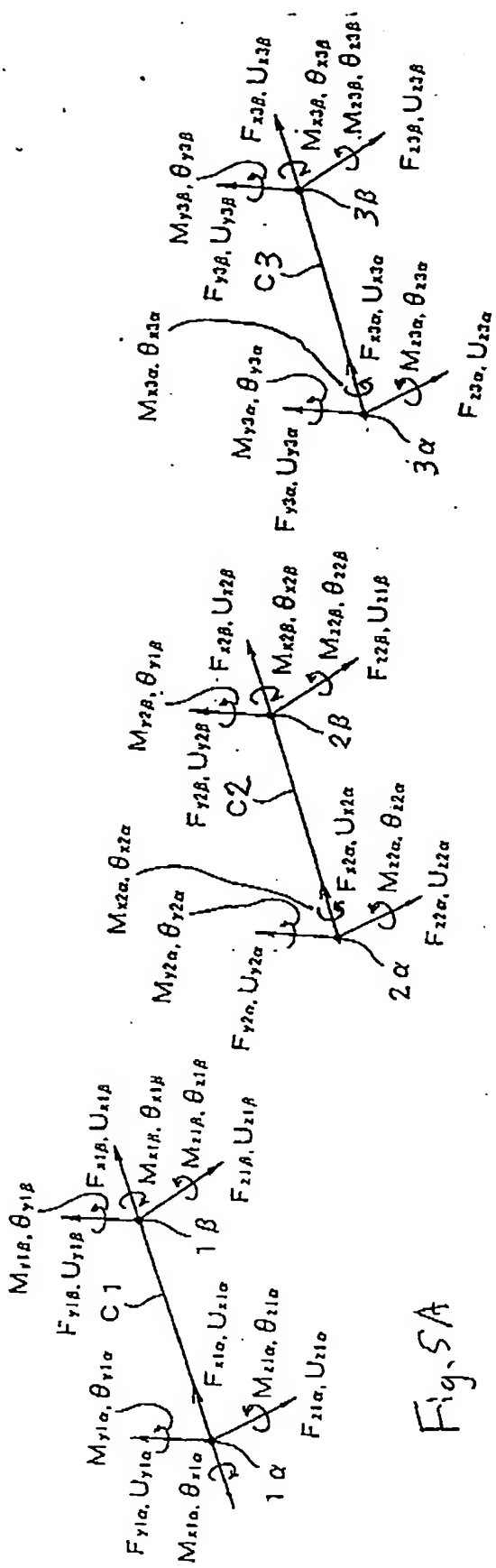
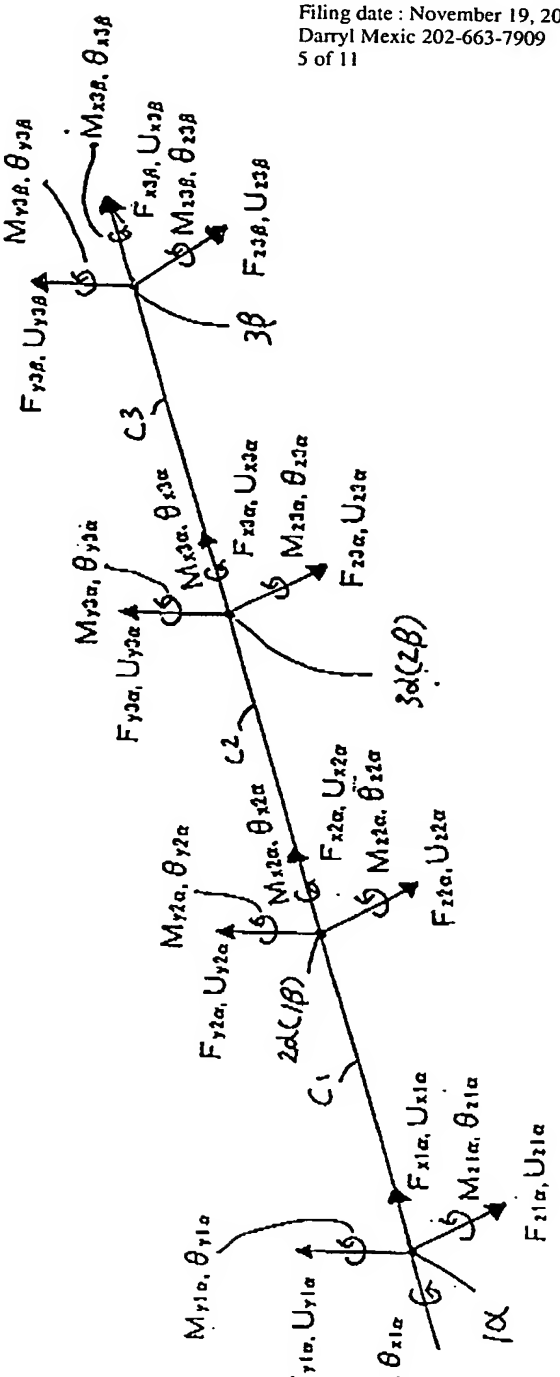

$M_{y1\beta}, \theta_{y1\beta}$
$F_{y1\beta}, U_{y1\beta}$
$F_{z1\beta}, U_{x1\beta}$
$M_{z1\beta}, \theta_{x1\beta}$
$M_{y1\alpha}, \theta_{y1\alpha}$
$F_{y1\alpha}, U_{y1\alpha}$
$M_{x1\alpha}, \theta_{x1\alpha}$
$F_{x1\alpha}, U_{z1\alpha}$
$M_{z1\alpha}, \theta_{z1\alpha}$
$F_{z1\alpha}, U_{z1\alpha}$
C1
1β
1α
$M_{x2\beta}, \theta_{x2\beta}$
$M_{y2\beta}, \theta_{y2\beta}$
$F_{x2\beta}, U_{x2\beta}$
$F_{y2\beta}, U_{y2\beta}$
$M_{z2\beta}, \theta_{z2\beta}$
$F_{z2\beta}, U_{z1\beta}$
$M_{x2\alpha}, \theta_{x2\alpha}$
$M_{y2\alpha}, \theta_{y2\alpha}$
$F_{x2\alpha}, U_{x2\alpha}$
$F_{y2\alpha}, U_{y2\alpha}$
$M_{z2\alpha}, \theta_{z2\alpha}$
$F_{z2\alpha}, U_{z2\alpha}$
C2
2β
2α
$M_{x3\beta}, \theta_{x3\beta}$
$M_{y3\beta}, \theta_{y3\beta}$
$F_{x3\beta}, U_{x3\beta}$
$F_{y3\beta}, U_{y3\beta}$
$M_{z3\beta}, \theta_{z3\beta}$
$F_{z3\beta}, U_{z3\beta}$
$M_{x3\alpha}, \theta_{x3\alpha}$
$M_{y3\alpha}, \theta_{y3\alpha}$
$F_{x3\alpha}, U_{x3\alpha}$
$F_{y3\alpha}, U_{y3\alpha}$
$M_{z3\alpha}, \theta_{z3\alpha}$
$F_{z3\alpha}, U_{z3\alpha}$
C3
3β
3α

Fig. 5A


$M_{y1\beta}, \theta_{y1\beta}$
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$M_{y1\alpha}, \theta_{y1\alpha}$
$F_{y1\alpha}, U_{y1\alpha}$
$M_{x1\alpha}, \theta_{x1\alpha}$
$F_{x1\alpha}, U_{z1\alpha}$
$M_{z1\alpha}, \theta_{z1\alpha}$
$F_{z1\alpha}, U_{z1\alpha}$
C1
1β
1α
$M_{x2\beta}, \theta_{x2\beta}$
$M_{y2\beta}, \theta_{y2\beta}$
$F_{x2\beta}, U_{x2\beta}$
$F_{y2\beta}, U_{y2\beta}$
$M_{z2\beta}, \theta_{z2\beta}$
$F_{z2\beta}, U_{z2\beta}$
$M_{x2\alpha}, \theta_{x2\alpha}$
$M_{y2\alpha}, \theta_{y2\alpha}$
$F_{x2\alpha}, U_{x2\alpha}$
$F_{y2\alpha}, U_{y2\alpha}$
$M_{z2\alpha}, \theta_{z2\alpha}$
$F_{z2\alpha}, U_{z2\alpha}$
C2
2β
2α(1β)
$M_{x3\beta}, \theta_{x3\beta}$
$M_{y3\beta}, \theta_{y3\beta}$
$F_{x3\beta}, U_{x3\beta}$
$F_{y3\beta}, U_{y3\beta}$
$M_{z3\beta}, \theta_{z3\beta}$
$F_{z3\beta}, U_{z3\beta}$
$M_{x3\alpha}, \theta_{x3\alpha}$
$M_{y3\alpha}, \theta_{y3\alpha}$
$F_{x3\alpha}, U_{x3\alpha}$
$F_{y3\alpha}, U_{y3\alpha}$
$M_{z3\alpha}, \theta_{z3\alpha}$
$F_{z3\alpha}, U_{z3\alpha}$
C3
3β
3α(2β)

Fig. 5B

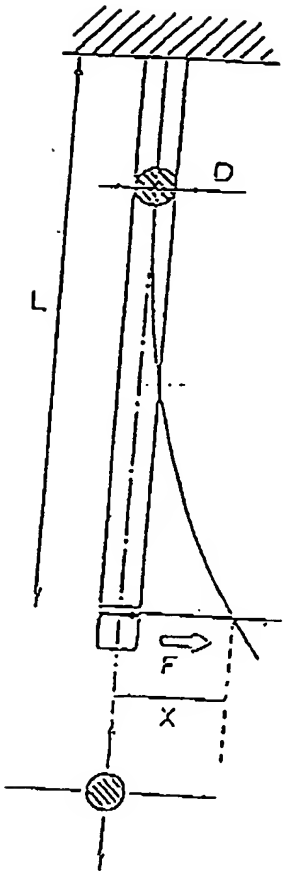


FIG. 6A

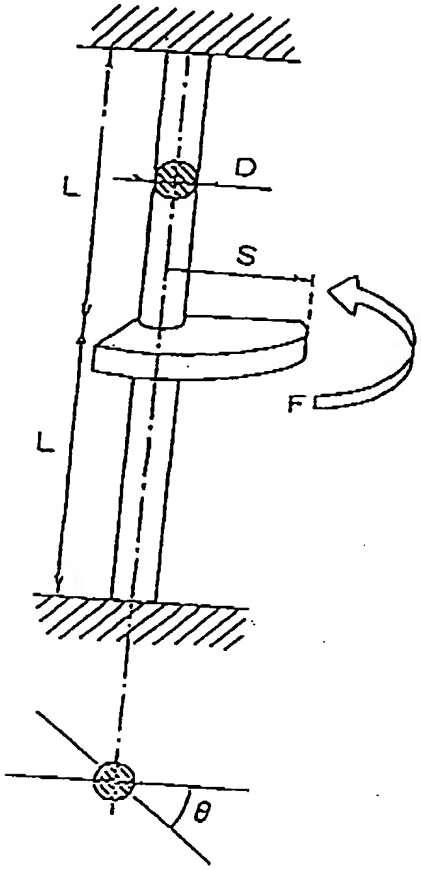


FIG. 6B

EXTERIOR TYPE	W/H DIAMETER 1-5	W/H DIAMETER 6-10	W/H DIAMETER 11-15	. . .
NO EXTERIOR	10	12	14	. . .
TAPE-WOUND 1	20	. . .	. . .	. . .
TAPE-WOUND 2	30	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .

FIG. 7

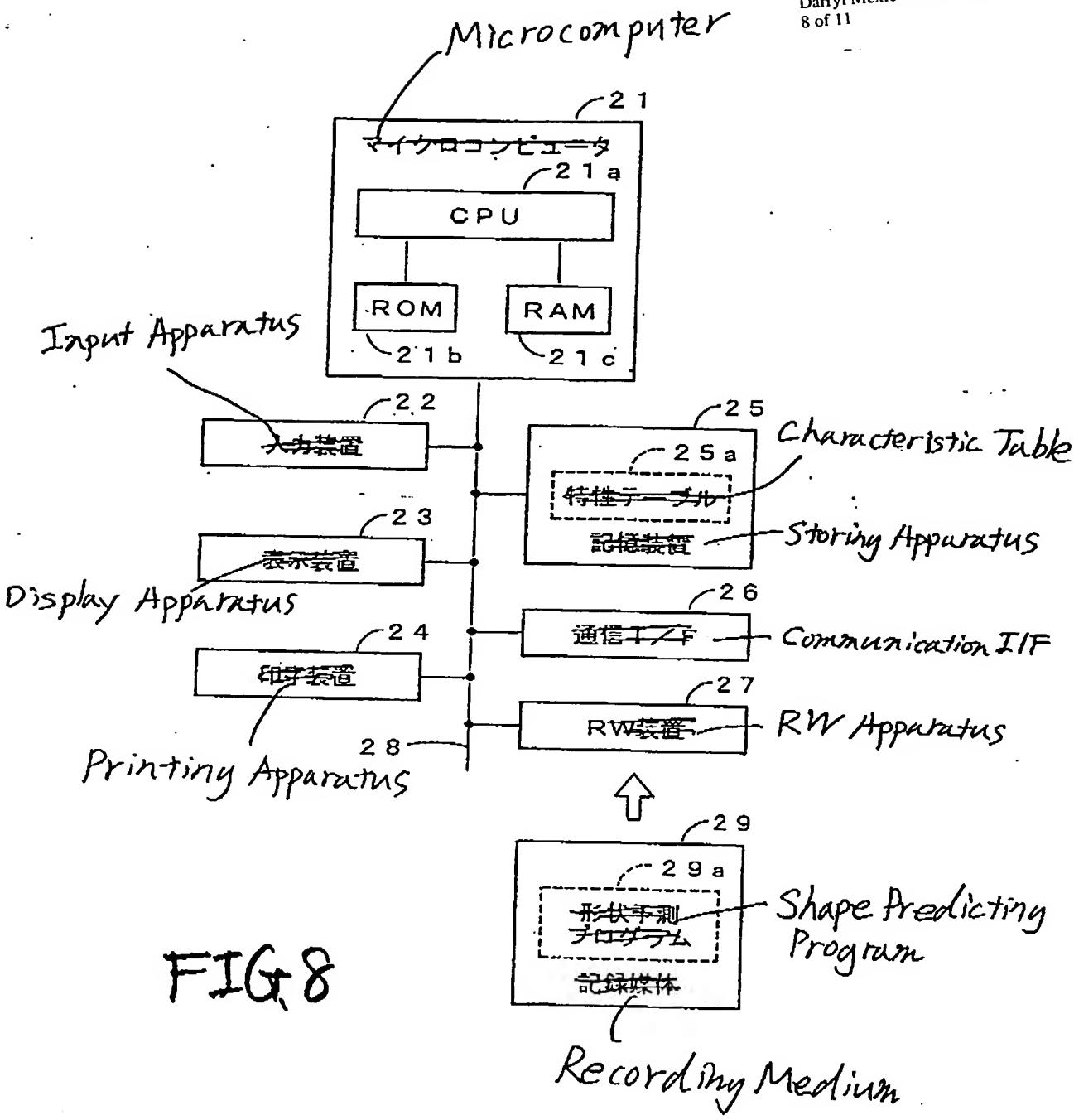
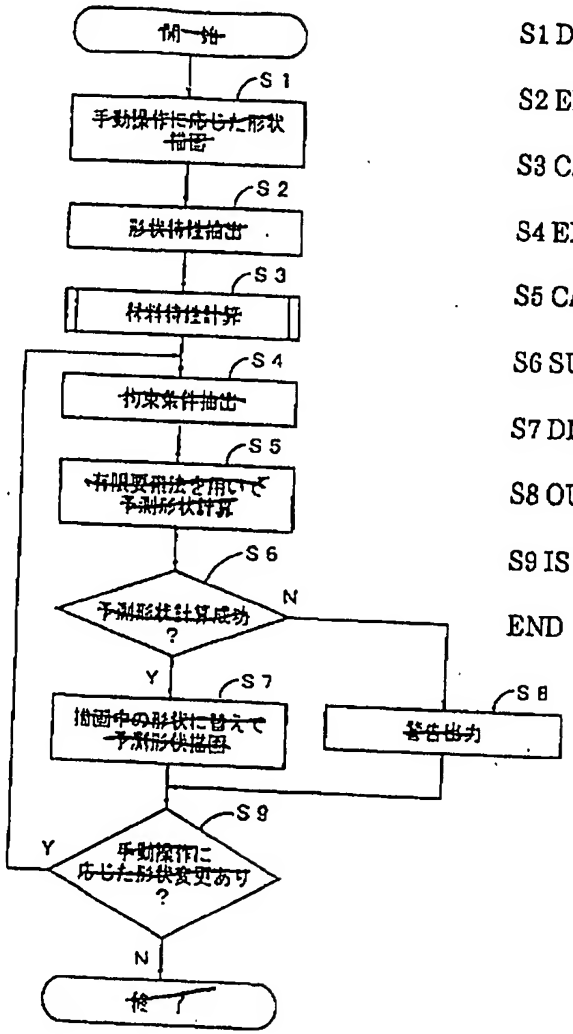

Microcomputer
21
マイクロコンピュータ
21a
CPU
ROM
RAM
21b
21c
Input Apparatus
22
入力装置
25
25a
特性テーブル
Characteristic Table
記憶装置
Storing Apparatus
23
表示装置
Display Apparatus
26
通信I/F
Communication I/F
24
印字装置
27
RW装置
RW Apparatus
28
Printing Apparatus
29
29a
形状予測プログラム
Shape Predicting Program
記録媒体
Recording Medium

FIG. 8



START,

S1 DRAW SHAPE IN CORRESPONDENCE WITH MANUAL OPERATION,

S2 EXTRACT SHAPE CHARACTERISTIC,

S3 CALCULATE MATERIAL CHARACTERISTIC,

S4 EXTRACT CONSTRAINING CONDITION,

S5 CALCULATE PREDICTED SHAPE BY USING FEM,

S6 SUCCESSFUL IN CALCULATING PREDICTED SHAPE?,

S7 DRAW PREDICTED SHAPE IN PLACE OF SHAPE BEING DRAWN,

S8 OUTPUT ALARM,

S9 IS THERE CHANGE IN SHAPE IN CORRESPONDENCE WITH MANUAL OPERATION?,

END

Fig. 9

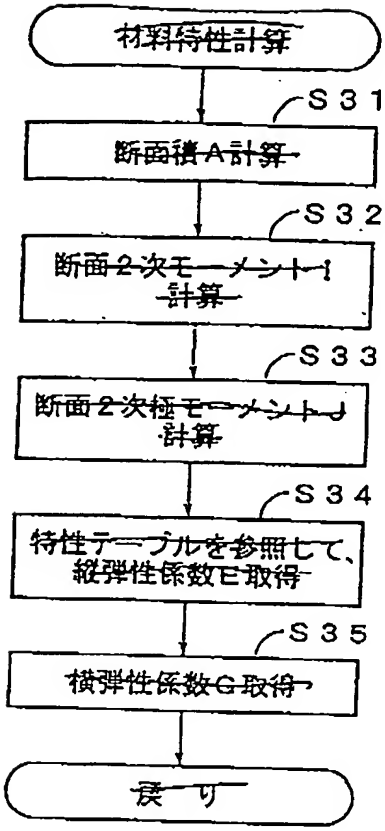


Fig. 10

MATERIAL CHARACTERISTIC CALCULATION

S31 CALCULATE SECTIONAL AREA A

S32 CALCULATE MOMENT OF INERTIA I

S33 CALCULATE POLAR MOMENT OF INERTIA G

S34 ACQUIRE LONGITUDINAL MODULUS OF ELASTICITY E IN REFERENCE TO CHARACTERISTIC TABLE

S35 ACQUIRE TRANSVERSE MODULUS OF ELASTICITY G

RETURN

Fig. 11A

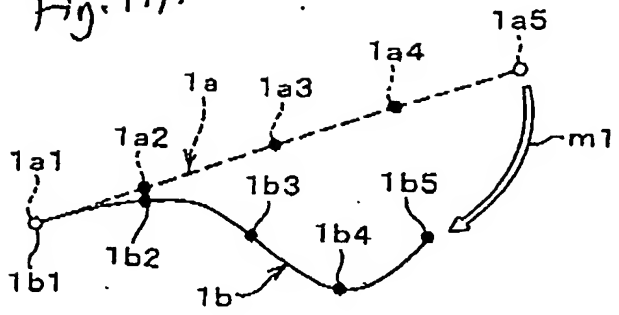


Fig. 11B

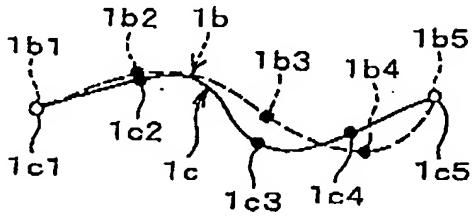


Fig. 11C

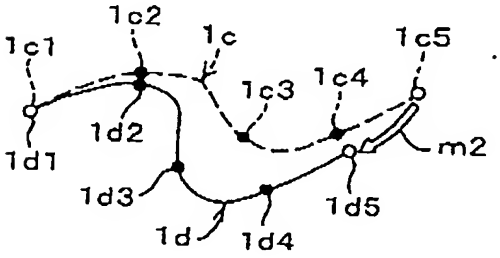


Fig. 11D

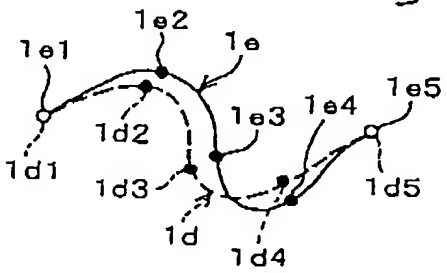
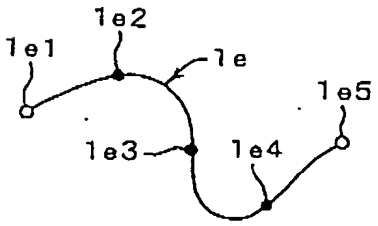



Fig. 11E